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Group 14

Design and Implementation of a Long-Wavelength Infrared Detection System

Project Description

- Long wavelength IR detection system developed and prototyped for Dr. Jason Rhinelander of Reiland Systems Limited.
- Reiland Systems Ltd. currently working on an advanced detection system capable of environmental monitoring/surveillance.
- Goal of project is to design a prototype with similar detection capabilities to act as a test platform , using a PIR sensor interfaced with a programmable microcontroller.
- Project Requirements
  - PCB design and fabrication
  - DIP sockets for component replacement
  - In-circuit programming for PIC microcontroller
  - 3D printed prototype casing*

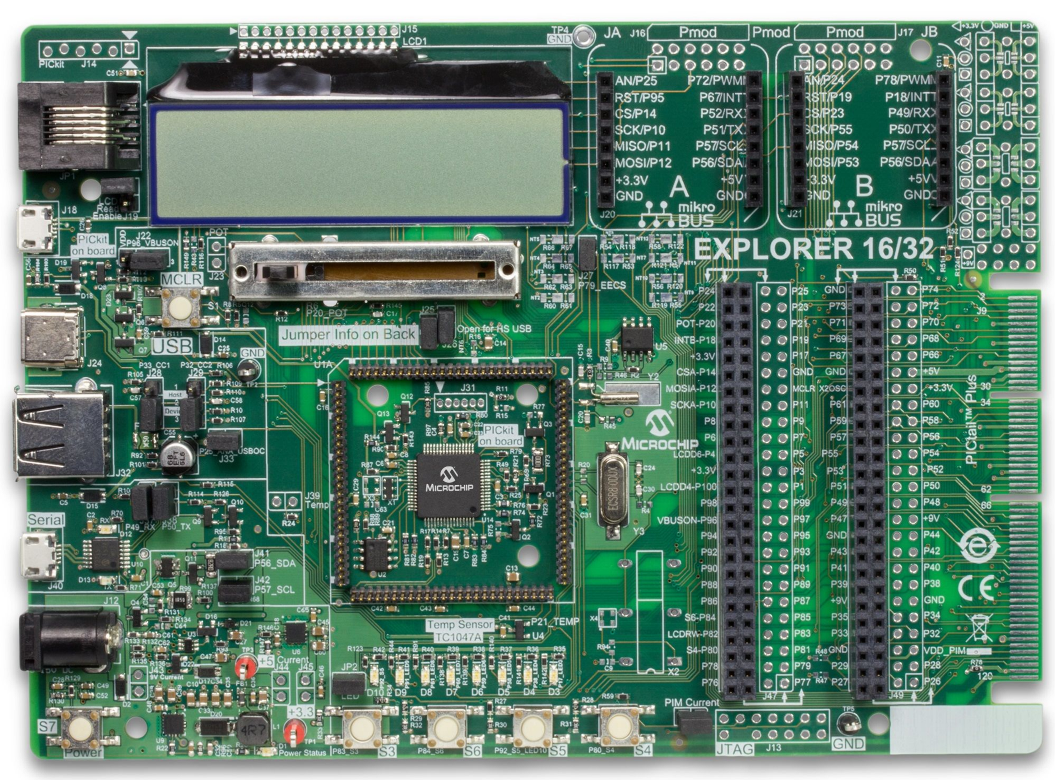


Figure 1: Shows the Microchip Explorer 16/32 Development Kit supplied to the group for hardware and software testing capabilities.

Project Planning

- *Work Plan Issues: With the unprecedented events that occured (COVID-19), some aspects of the prototype completion were out of our hands and unable to be completed, such as the fabrication of the 3D printed housing for the overall device.
- Project Milestones: The project milestones were subdivided into five main stages:
  - Circuit design to obtain data from the PIR sensor
  - PCB design and fabrication for easy system integration and smaller form factor
  - Software development for the microcontroller to retrieve and process sensor data
  - Finalize integration between the hardware and software
  - Finish final prototype and conduct final testing

System Description

The prototype of the device was divided into two overarching segments: hardware and software operations. The hardware component supports the PIR sensor and captures the output signal, while the software component is required to examine the signal from the sensor circuit.

The system architecture includes the PIR sensor circuitry, the microcontroller, power supply, and system enclosure. Listed below are the physical components of the system:

- ZRE200GE PIR Sensor
- LM741CN Operational Amplifier
- LM317T Voltage Regulator
- 9V Power Supply
- LED Alerting System
- PCB
- 3D Printed Housing
- Microcontroller and Communication System
- Software

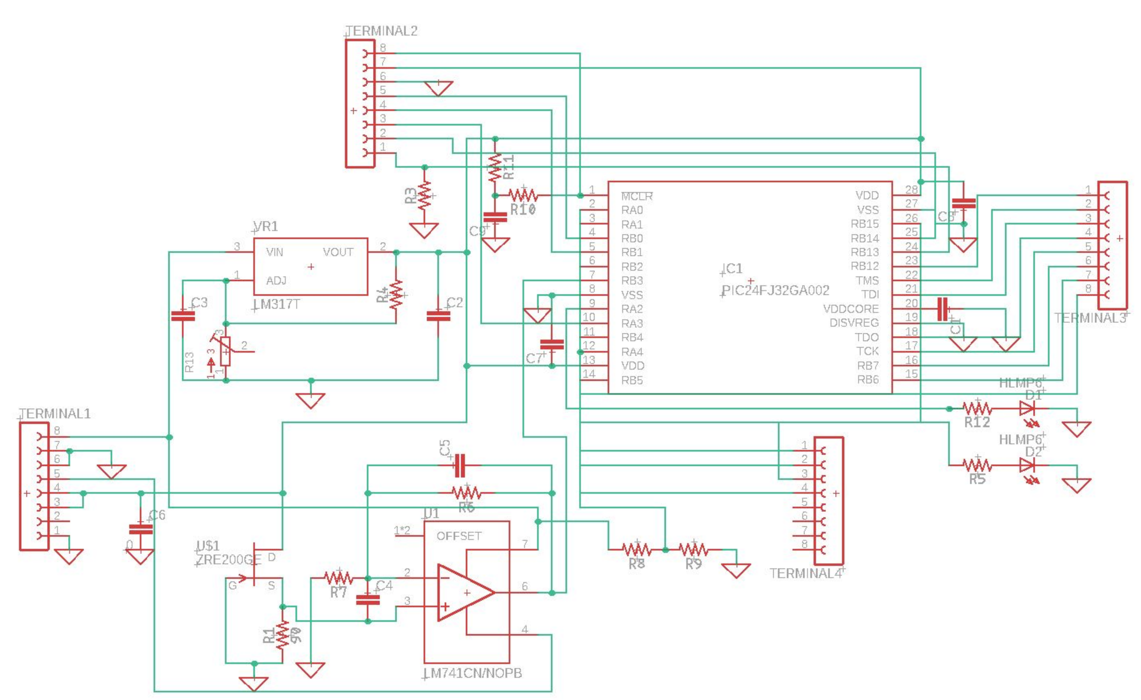
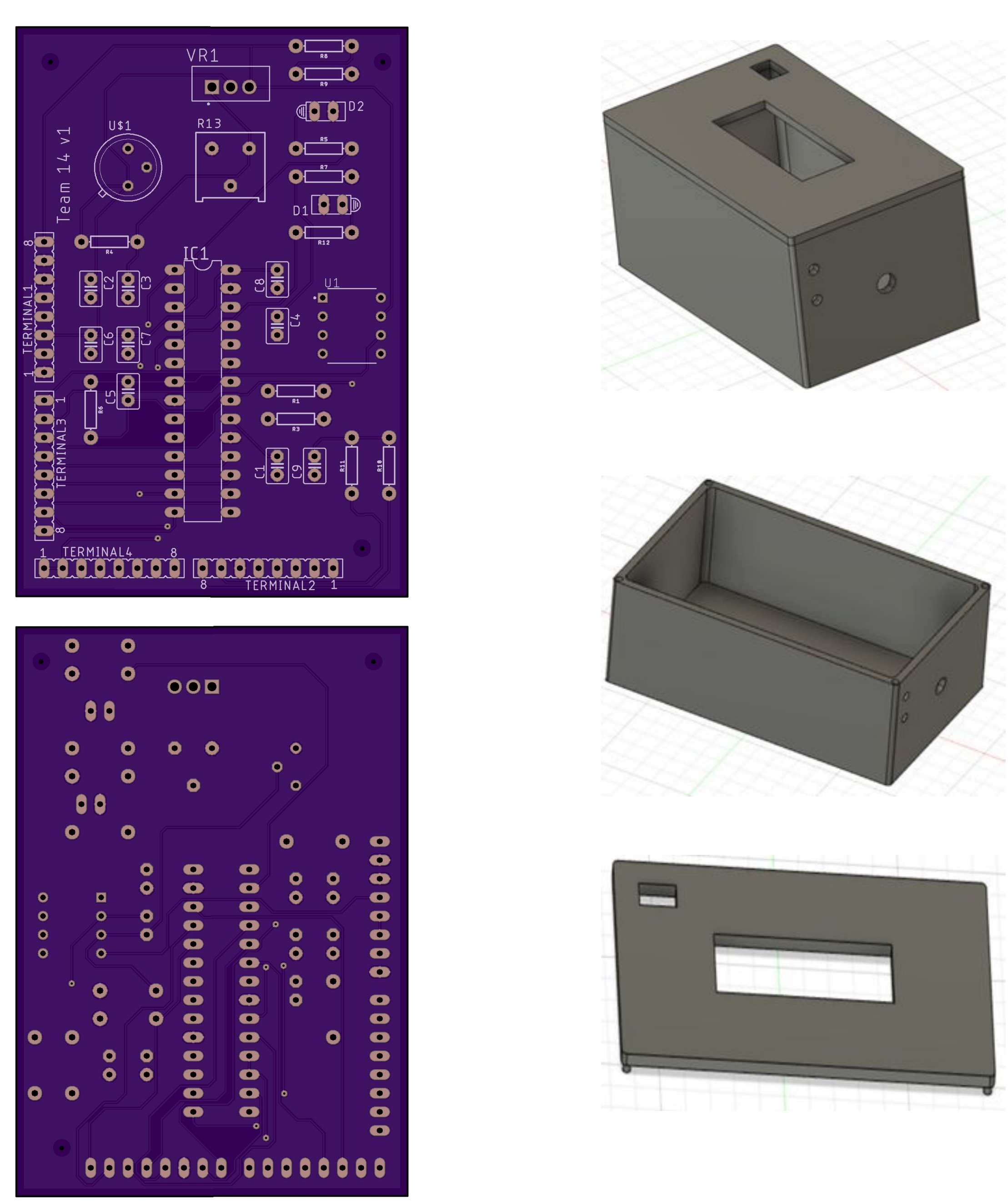


Figure 2: Circuit schematic used to design the system PCB



Figure(s) 3: Final PCB design and proposed housing CAD drafts

System Description Cont.

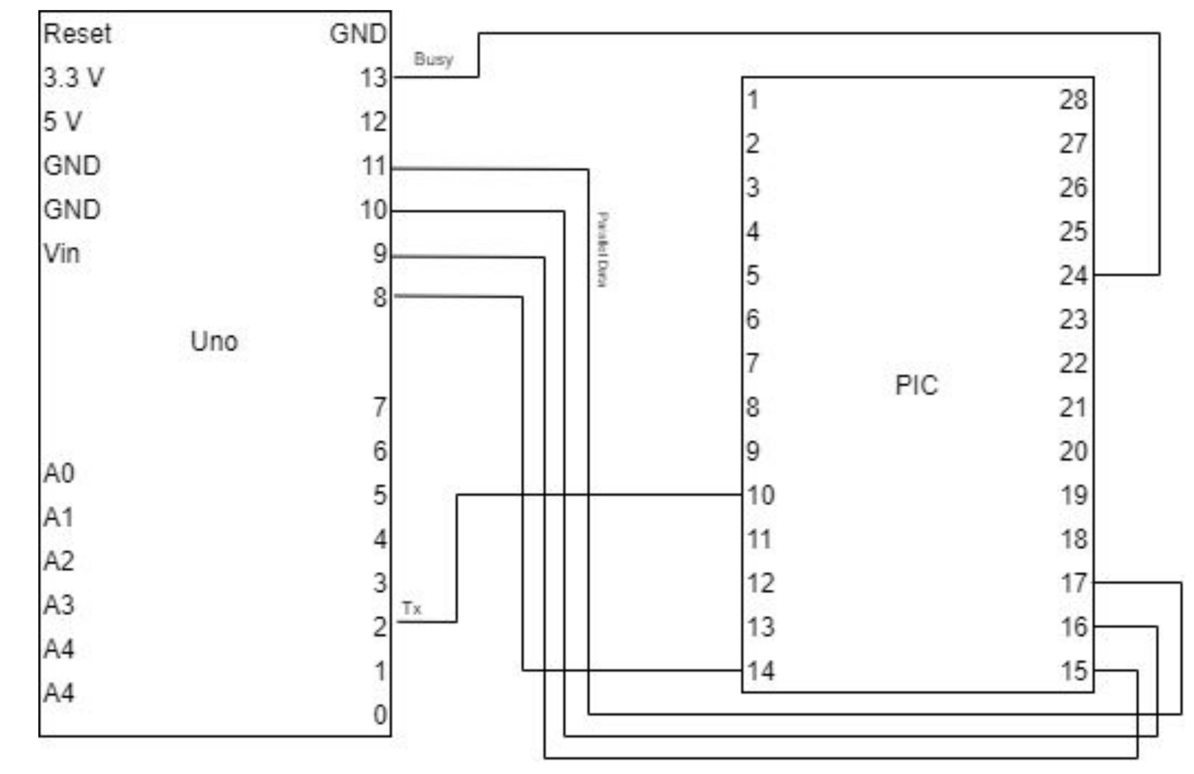


Figure 4: Communications wiring between Uno and PIC

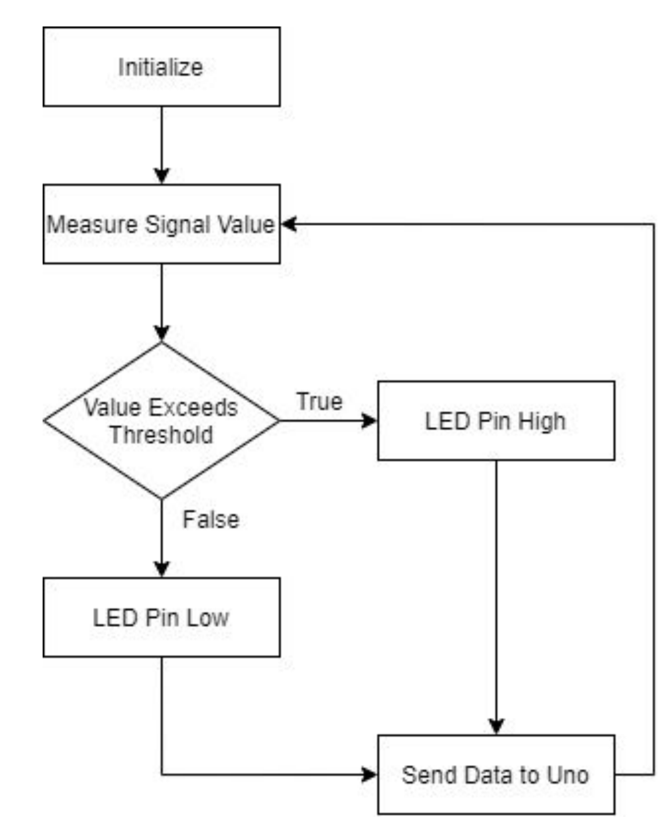
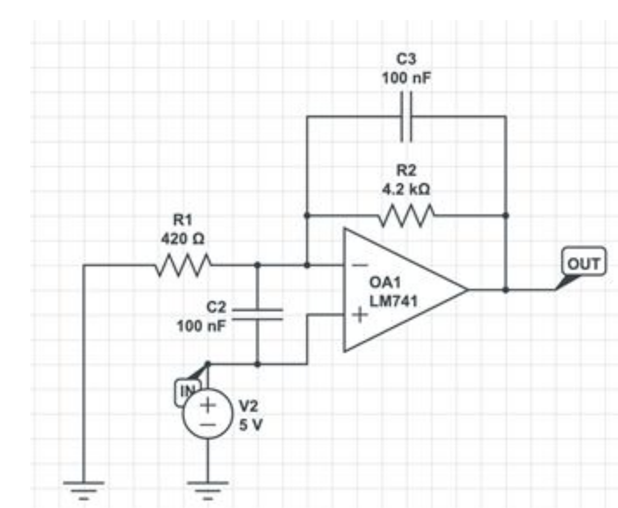


Figure 5: PIC flow chart describing main loop

Results and Testing

Sensor Circuit Results: Shown in figure(s) 6 below, the op-amp was able to achieve a gain of 11, and the voltage regulator was able to regulate the 9V output from the batteries down to 3.3V to power the PIR sensor and PIC microcontroller.

PCB Testing Results: From the PCB testing performed using a multimeter and proper battery connections, it was found that all except one connection was functioning properly. The one exception was two output pins on the microcontroller wired in parallel making the pin able to only output one signal at a time.

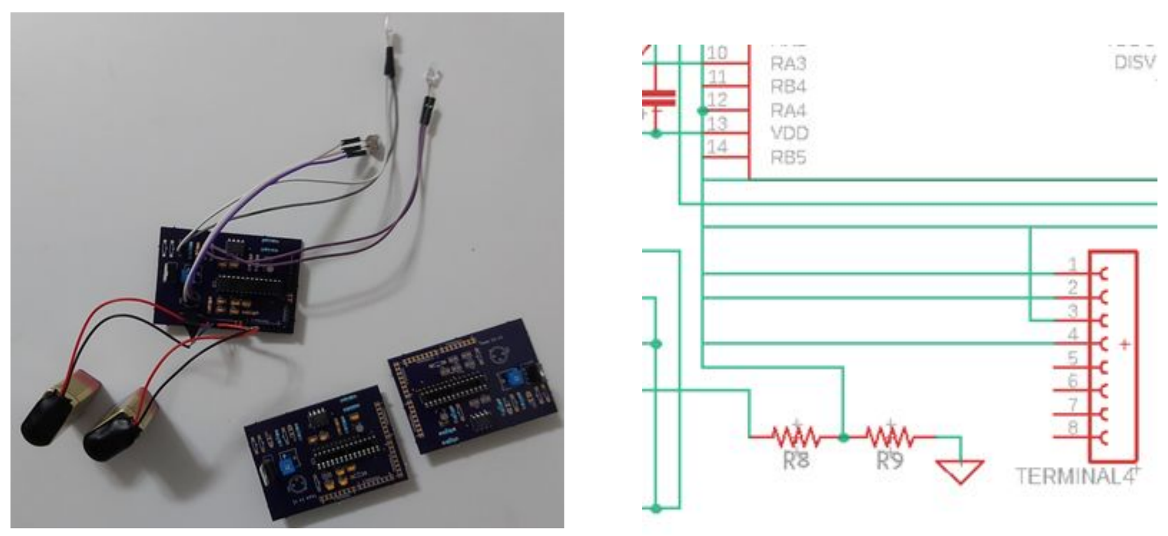


V(IN)	1.000 V
V(OUT)	11.00 V

Figure(s) 6: Op-amp circuit simulation with results using CircuitLab

Results and Testing Cont.

Software and Microcontroller Results: The PIC microcontroller, embedded into the PCB, successfully polled the PIR sensor and calculated the signal using internal analog to digital conversion tools. From our lab setup, this resulted in an LED illuminating in the presence of an IR emitting body in from of the PIR sensor. The system was able to successfully poll the PIR sensor and display the analog value on the PC through a serial monitor, as well as communicate with an Arduino Uno as seen in figure 4.



Figure(s) 7: Final construction of prototype PCB with components, and pins wired in parallel

Recommendations/Refining the Design

Below outline some future design recommendations given more time and resources:

- *Weatherproofing Case:* A case capable of keeping the unit operable at temperatures of -30 to 70 degrees celsius in a multitude of weather settings
- *Rechargeable Battery/Solar Power:* While the 9V batteries are reliable for a basic prototype, rechargeable batteries capable of being charged using solar power would help with ease of use as well as operating in an outdoor environment.
- *Wireless Alerting:* The implementation of a wireless alerting system would allow the user to monitor the outputs of the device without the need for being in such close proximity to the device.
- *PCB Design:* Given more time, the PCB can be designed to occupy a smaller form factor, potentially even around half the size. This would result in a smaller overall device.

Sources

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